

**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594**

Hazardous Materials Factual Report

October 20, 1999

DCA-99-MZ-005

A. Incident Identification

Location:	Los Angeles, California
Date and Time:	April 28, 1999; 3:00 p.m.
Hazardous Materials:	Lithium Batteries, Div. 4.3 (Dangerous When Wet)
Injuries:	None
Carrier:	Northwest Airlines, Inc.
Shipper:	SANYO Electric Trading Co., Ltd.
Transportation Mode:	Air

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C. The Incident

At 3:00 p.m., on April 28, 1999, a fire destroyed freight, including lithium batteries, on two aircraft cargo pallets at the Northwest Airlines cargo facility at Los Angeles International Airport. The pallets had been taken off an inbound passenger-carrying flight from Osaka, Japan. The aircraft was a Boeing 747, operated by Northwest Airlines as flight 0026.

D. Events Preceding The Incident

Flight 0026 arrived at Los Angeles International Airport about 1020 local time. At 1120, a Northwest equipment operator picked up a pallet loaded with lithium batteries from a dolly and tried to set it on the ground near the cargo facility. To get the pallet to slide off the forklift blades, the operator stopped his vehicle quickly. As the pallet came off the blades, it rolled onto its side against a pallet from another shipment.

The pallet was left resting against the second pallet until 1233, when two equipment operators separated the pallets and righted the pallet with the batteries by placing the forklift blades under the boxes. The operator who righted the pallet said that the pallet seemed to be "top-heavy" and difficult to maneuver. Another equipment operator who was in the area shortly after the pallet was righted stated that several batteries were on the ground near the area where the pallets had been separated, indicating that some of the boxes of batteries may have been damaged.

At 1457, the pallet that had overturned was picked up again and moved next to another pallet containing lithium batteries along with other types of batteries and cargo. Three minutes later, at 1500, a Northwest equipment operator noticed smoke, followed quickly by a small fire on the back of the previously overturned pallet. (Appendix K & Security Video Tape)

E. Emergency Response

Another equipment operator on a forklift moved that pallet away from the rest of the pallets to prevent the fire from spreading. While the pallet was being moved, the fire spread to the adjoining pallet containing lithium batteries. Both pallets then erupted in flames. The fire department was notified, and several Northwest employees began fighting the fire with portable extinguishers and a fire hose. The employees noted that each time they thought the fires were out, they flared up again. Several employees saw the lithium batteries "popping" or "jumping" in the fire. The fire department arrived at 1509 and by 1525 had extinguished the fires by separating the packages involved in the fire and deluging them with water. (Appendix K & Security Video Tape)

F. Hazardous Materials Information

The two pallets involved in the fire contained 120,000 nonrechargeable lithium batteries: 120 12-kilogram (kg) packages containing 1,000 batteries in each package. Each battery was about 1 inch long, ½ inch in diameter, and contained about 0.4 grams of lithium. Shipping documents indicated that they were "Not Dangerous Goods."¹ (Appendices A, B & L)

Lithium, which is contained inside each battery, is a combustible alkali metal that self-ignites in air at 352° F. When exposed to water, lithium reacts exothermically and releases hydrogen, creating a dangerous fire risk. Fires involving lithium are extremely difficult to extinguish. Extinguishers using water, gas, or certain dry chemicals cannot control this type of fire. The Department of Transportation (DOT) classifies lithium metal as a division 4.3 material (dangerous when wet).² Lithium metal may not be shipped on passenger aircraft but can be shipped on cargo aircraft, provided each package weighs no more than 15 kg.

When lithium batteries were first developed, they were authorized to be shipped under DOT exemptions which classified them as "flammable solid, dangerous-when-wet" materials (currently called division 4.3) because they contained lithium metal. Exemptions were issued in the late 1970s allowing lithium batteries containing less than 0.5 grams of lithium per cell and no more than 1 gram of lithium per battery (like the batteries involved in this incident) to be transported exempt from certain hazardous materials regulations, according to the DOT's Research and Special Programs Administration (RSPA). By 1979, these exemptions were incorporated into both U.S. (49 CFR 173.185) and international (International Civil Aviation Organization [ICAO]) air transportation requirements as exceptions. The lithium batteries involved in the fire in Los Angeles International Airport met the criteria for exception from the hazardous materials regulations.

¹ "Dangerous goods" is an international term for hazardous materials.

² Title 49 *Code of Federal Regulations* (CFR) 173.124(c) defines division 4.3 (dangerous when wet) material as "a material that, by contact with water, is liable to become spontaneously flammable or to give off flammable or toxic gas at a rate greater than 1 liter per kilogram of the material, per hour, when tested in accordance with [the] UN Manual of Tests and Criteria."

Also, according to RSPA, in 1988, the United Nations (UN) Committee of Experts on Transportation of Dangerous Goods created a new shipping name specifically for lithium batteries and classified them as either class 9, miscellaneous hazardous material, or as non-regulated depending on the amount of lithium in each battery and the results of certain design-type tests.³ The UN also provided an exception from testing for small batteries with limited amounts of lithium. According to RSPA, the UN decisions were based on their conclusion that the lithium is hermetically sealed within the batteries and would not be exposed to water during normal handling in transportation, thus the "dangerous when wet" classification did not apply. Lithium batteries were classified as a class 9, miscellaneous hazardous material because of the potential for an electrochemical reaction that generates heat and gas should a short circuit occur. Today, both the DOT and ICAO⁴ have harmonized their regulations with the UN's and classify lithium batteries that do not meet exceptions as a class 9, miscellaneous hazardous material.

Lithium batteries not meeting the exception or testing criteria are considered regulated hazardous materials that must be transported in compliance with the hazardous materials regulations. They must be properly identified on the shipping documents and have appropriately marked and labeled packaging. No more than 5 kg of batteries per package may be transported on a passenger-carrying aircraft, and the air carrier must notify the pilot-in-command that they are being loaded on the aircraft. Additionally, before transportation, batteries shipped as a regulated item must be tested in accordance with the requirements in the UN's *Transport of Dangerous Goods Manual of Tests and Criteria*. (Appendices D-G&K)

Battery Testing—The Sanyo CR-2 lithium batteries involved in the incident were not tested in accordance with the UN's *Transport of Dangerous Goods Manual of Tests and Criteria*, nor were they required to be tested. However, Sanyo had performed these tests on their CR-123A lithium battery. According to Sanyo, this battery is similar in design to the CR-2, although it is slightly larger (about ¼-inch longer and 1/16-inch wider in diameter) and contains a maximum of 0.5 grams of lithium.⁵ All the require tests were performed with successful results, with the exception of Test 5 (38.3.4.5), *Vibration, Shock and Low Capacity Cell*, which was not performed.

After the incident at Northwest's cargo terminal, on May 13, 1999, Sanyo performed Test 3 (38.3.4.3), *Vibration, Shock and Charge*, on a group of CR-2 batteries with successful results. (Appendix B)

³ United Nation's *Transport of Dangerous Goods Manual of Tests and Criteria*. The tests involve various combinations of simulated altitude, temperature change, vibration, shock, charging, discharging, low-capacity cells, and electrical shorts (external and internal). A requirement of a successful test is that the lithium batteries not disassemble (break open) or cause a fire during testing.

⁴ DOT regulations allow the transportation of hazardous materials by aircraft to, from, and within the United States in accordance with ICAO's *Technical Instructions for the Safe Transportation of Dangerous Goods by Air*. For more information, see 49 CFR 171.11.

⁵ UN testing is not required for this size battery.

G. Hazardous Materials Packaging

Each fiberboard box contained 1,000 lithium batteries in two stacked fiberboard trays, each holding 500 batteries standing with the positive terminal up, arranged in 20 rows of 25 batteries. There were strips of paper or single wall cardboard between each row. Each tray had a corrugated fiberboard spacer on top of the batteries. The batteries were tightly packed in the trays allowing very little movement. (Appendices B&L)

There were no DOT hazardous materials markings or labels on the boxes, nor were markings and labels required. There were warnings on a label and on the sealing tape that stated "Warning: Do not short circuit batteries directly or via metallic contact of \oplus, \ominus terminals after removal from this packaging and during handling. Short-circuiting by stacking batteries can result in cell rupture due to gas or heat generation and may present a fire hazard or cause injury." (Appendix L)

Package Testing⁶—Sanyo had performed informal battery package tests (including a vibration test, a violent shock test, and a drop test) on sample packages of CR-123A lithium batteries with successful results. Similar testing had not been performed on the packages of CR-2 lithium batteries before the incident, nor were the packages required to be tested. After the incident, a UN Packing Group II drop test and a stacking test was performed on sample packages of CR-2 batteries with successful results. (Appendix B)

Damages—The postincident examination revealed that the damage to the cargo on the pallets was generally limited to the lithium batteries and their packaging. These batteries showed signs of bursting and melting. Some burn and sooting damage occurred to the packaging of the other batteries and cargo on the two pallets. For details see the Fire Investigation Factual Report. (Appendix L)

H. Other Incidents Involving Lithium Batteries

Interviews with Northwest employees revealed that the day after the April 28 fire, another small fire started when a lithium battery that had unintentionally been left on the floor of the cargo facility became lodged under a pallet and ignited as a forklift slid the pallet across the floor. Postincident examination of this battery revealed that it had been abraded open. (Appendices K & L, Photo 10)

The Research and Special Programs Administration (RSPA) statistics for the past 10 years indicate that there have been five reported fires in transportation involving lithium batteries.⁷ One incident involved a box containing 25 lithium batteries, transported on a Federal Express aircraft, that caught fire in Federal Express's freight

⁶ Testing was performed on packaging loaded and prepared for shipment.

⁷ These are incidents reported to the Research and Special Programs Administration under 49 CFR 171.16. There may be other unreported incidents.

sorting facility in Memphis, Tennessee, on May 24, 1989. A hole was reportedly "burned completely through the inner and through the outer box." (Appendix J)

Also, while not shown on the RSPA database because the incident occurred in London, England, RSPA mentioned another incident involving lithium batteries in their *Advisory Guidance; Transportation of Batteries and Devices that Contain Batteries*.⁸

In May, 1994, while being delivered to a handling agent by road, a shipment of small lithium batteries destined for Gatwick Airport in London, England, was found emitting smoke from a Unit Loading Device. The shipment consisted of batteries, approximately the size of a dime and about 5mm high, which had been tossed loosely in a box. The batteries apparently short-circuited when exposed battery terminal tabs came into contact with other batteries, and subsequently started a fire that significantly damaged the shipment.

I. Cargo Handling

Employee interviews also revealed that it is not uncommon to accidentally overturn a pallet and that other loads of batteries have been damaged. One of the equipment operators who helped right the pallet involved in the fire stated that this was the third pallet that he had righted this year. Another operator stated that he had witnessed a pallet full of batteries turn completely upside down when it accidentally rolled off a dolly. A third operator reported seeing four crushed boxes of batteries on the bottom half of a pallet and "thousands" of small batteries spilling out as the pallet was taken off an international flight.

Aircraft pallets are designed as flat aluminum plates with no channels for forklift blades. They are lifted from the ground by driving the blades under the edge and beneath the pallet, which often results in the operator sliding the pallet along the ground before it can be picked up. When releasing an aircraft pallet, the operator cannot set it down and back out of the channels, but instead must lower the blades and stop rapidly or reverse the direction of the forklift so that the pallet tips forward, shifting the center of gravity and allowing the pallet to slide from the blades. (Appendices K, L & Security Video Tape)

J. History of Related Hazardous Materials Actions

The Safety Board has been concerned for some time about the risks associated with fires in aircraft cargo compartments, especially those involving hazardous materials. On October 24, 1988, as a result the Safety Board's investigation⁹ of a February 3, 1988, in-flight fire involving hydrogen peroxide solution (an oxidizer), the Safety Board issued Safety Recommendation A-88-127, which urged the Federal Aviation Administration

⁸ *Advisory Guidance; Transportation of Batteries and Devices that Contain Batteries*, Docket No. RSPA-99-5143, Federal Register Vol. 64, Number 129, p. 36744. July 7, 1999.

⁹ Hazardous Materials Accident Report—*In-Flight Fire, McDonnell Douglas DC-9-83, N569AA, Nashville Metropolitan Airport, Nashville, Tennessee, February 3, 1988* (NTSB/HZM-88/02).

(FAA) to consider the effects of authorized hazardous materials in cargo fires for all types of cargo compartments, and require appropriate safety systems to protect the aircraft and occupants. The FAA did not act on this recommendation and therefore, on April 19, 1993, Safety Recommendation A-88-127 was classified "Closed—Unacceptable Action."

On February 17, 1998, in response to the May 11, 1996, ValuJet accident in the Florida Everglades that involved an in-flight fire and resulted in 110 deaths, the FAA amended the Federal standards for cargo or baggage compartments. This amendment requires that inaccessible cargo compartments in new aircraft have fire or smoke detection and fire suppression equipment. However, the amendment does not require cargo compartments on existing aircraft to be retrofitted or converted to meet these standards until early 2001.

Also in response to the ValuJet accident, RSPA, in coordination with the FAA, initiated a study to assess the risks associated with the transportation of hazardous materials in aircraft cargo compartments. RSPA indicated that, based on the outcome of this study, it may ban certain hazardous materials from air transportation.¹⁰ Recent conversations with RSPA staff indicate that this study is nearing completion; however, lithium batteries were not included in the study. RSPA indicated that other hazardous materials, including lithium batteries, could be subjected to the same risk assessment. (Appendix K)

K. Actions Taken Since the Incident

Since the incident, Northwest Airlines has prohibited the transportation of lithium batteries on its aircraft unless the batteries are identified as a hazardous material and meet the shipping requirements for a regulated material, including appropriate marking and labeling and proper identification on the shipping documents. (Appendix I)


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¹⁰ The Safety Board supported this study in its February 28, 1997, comments to a Notice of Proposed Rulemaking (NPRM), Docket HM-224A, *Prohibition of Oxidizers Aboard Aircraft*, December 30, 1996.

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